

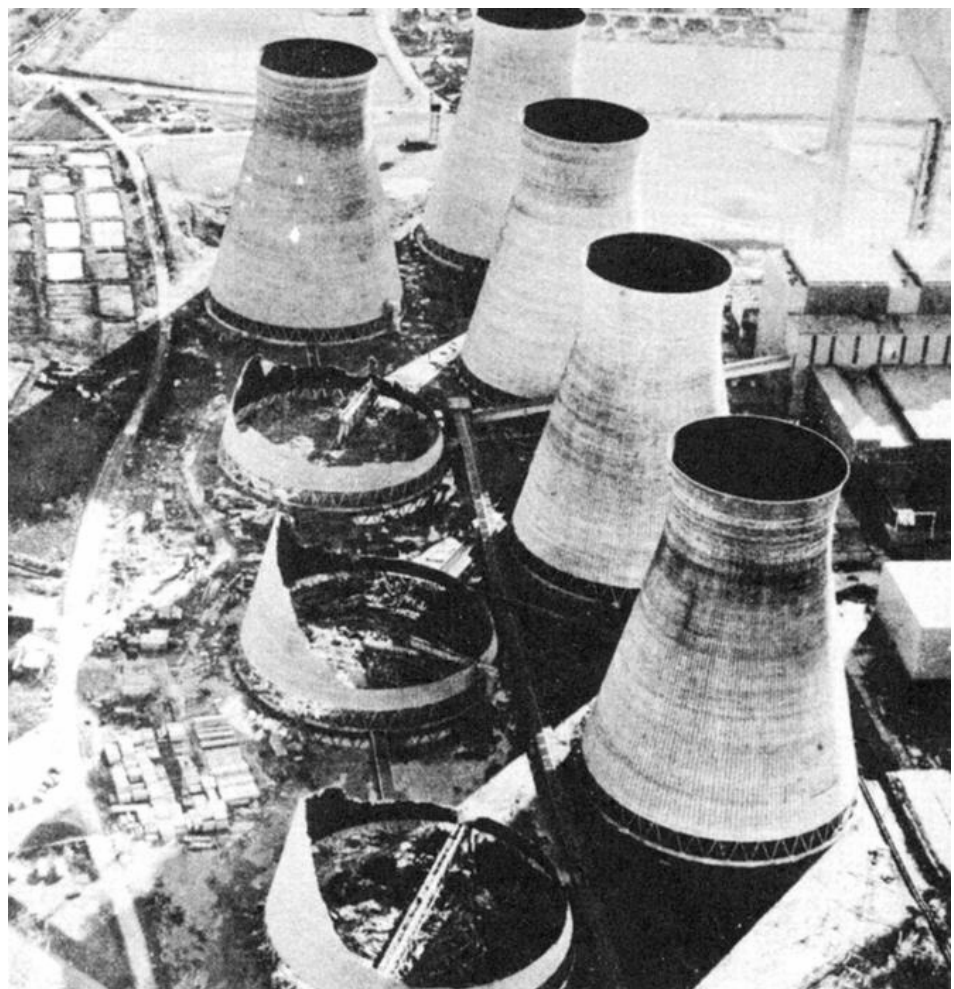
# Examples of structural failure

Origin	Design 20%	Execution 50%	Use 15%	Other 15%
Causes	Gross errors 80%		Actions 20%	



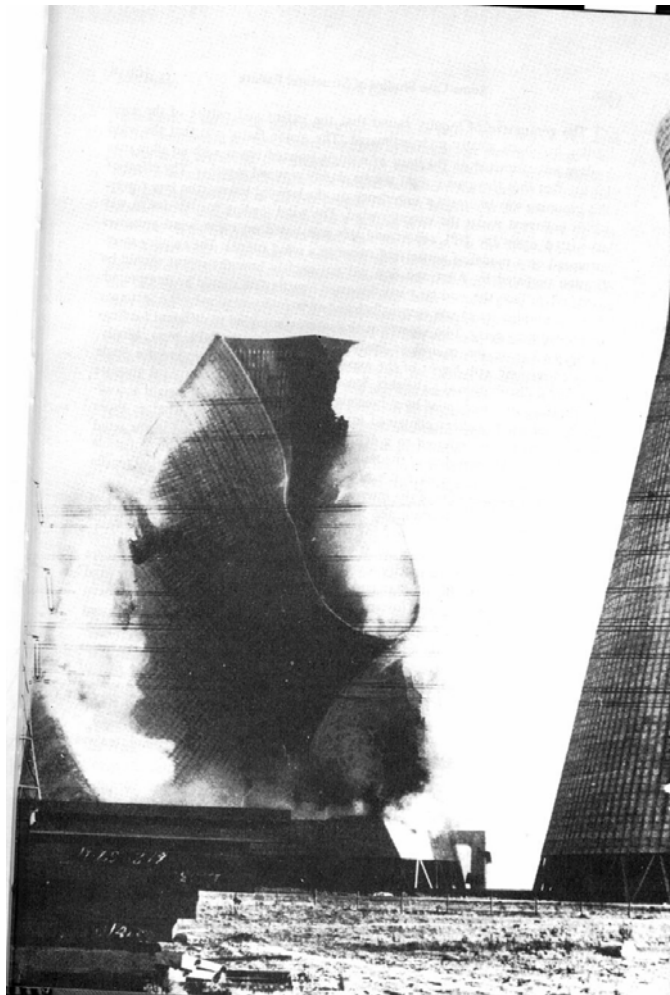
Historical cases  
Airport in Paris  
Shear punching  
Serviceability failure  
Environmental influences

Cooling  
Towers  
at  
Ferrybridge  
in  
Yorkshire,  
1965



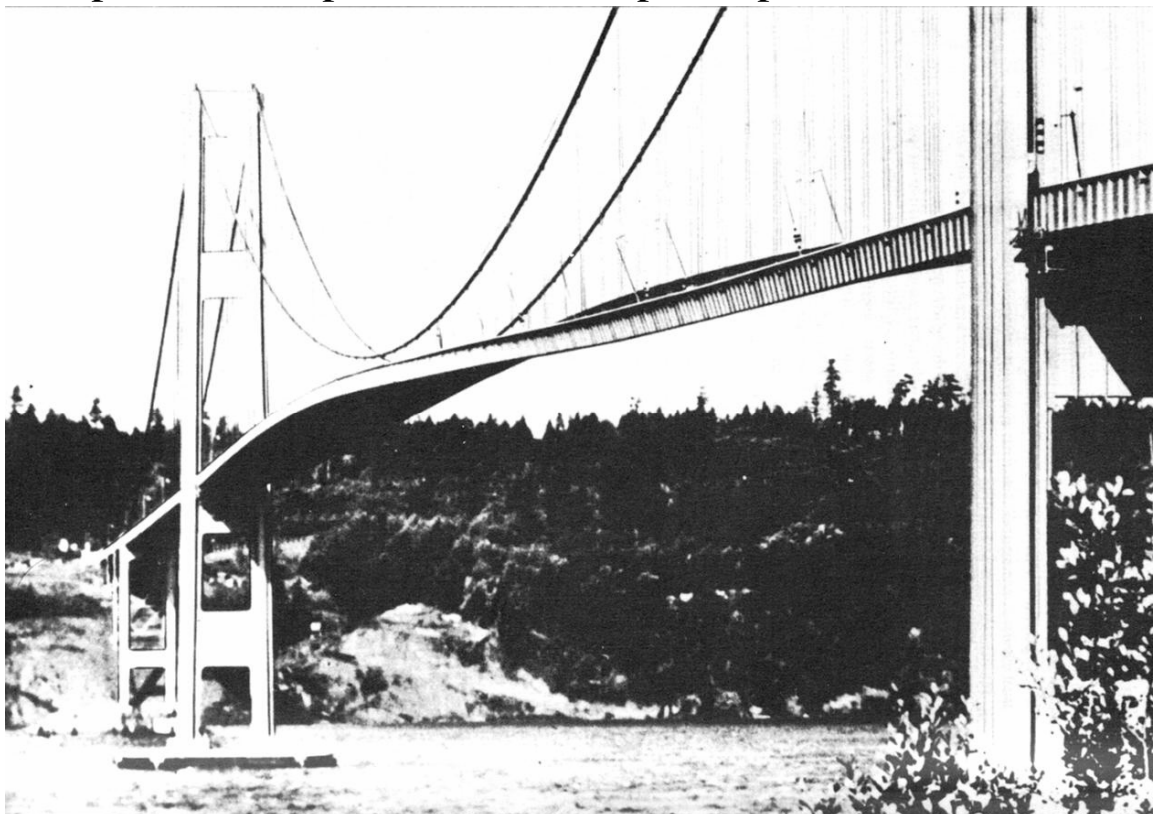
# Cooling towers

at Ferrybridge  
in Yorkshire,  
1965



# Tacoma Narrows Bridge 1940

span 853 m, span/width = 72, span/depth = 350





# Tacoma Narrows Bridge 1940

span 853 m, span/width = 72, span/depth = 350  
collapse caused by windward eddy



# Earthquake in Mexico City, 1985



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Damage  
caused by  
an overloaded  
lorry  
on a bridge





# Paris Airport Terminal, 05-2004

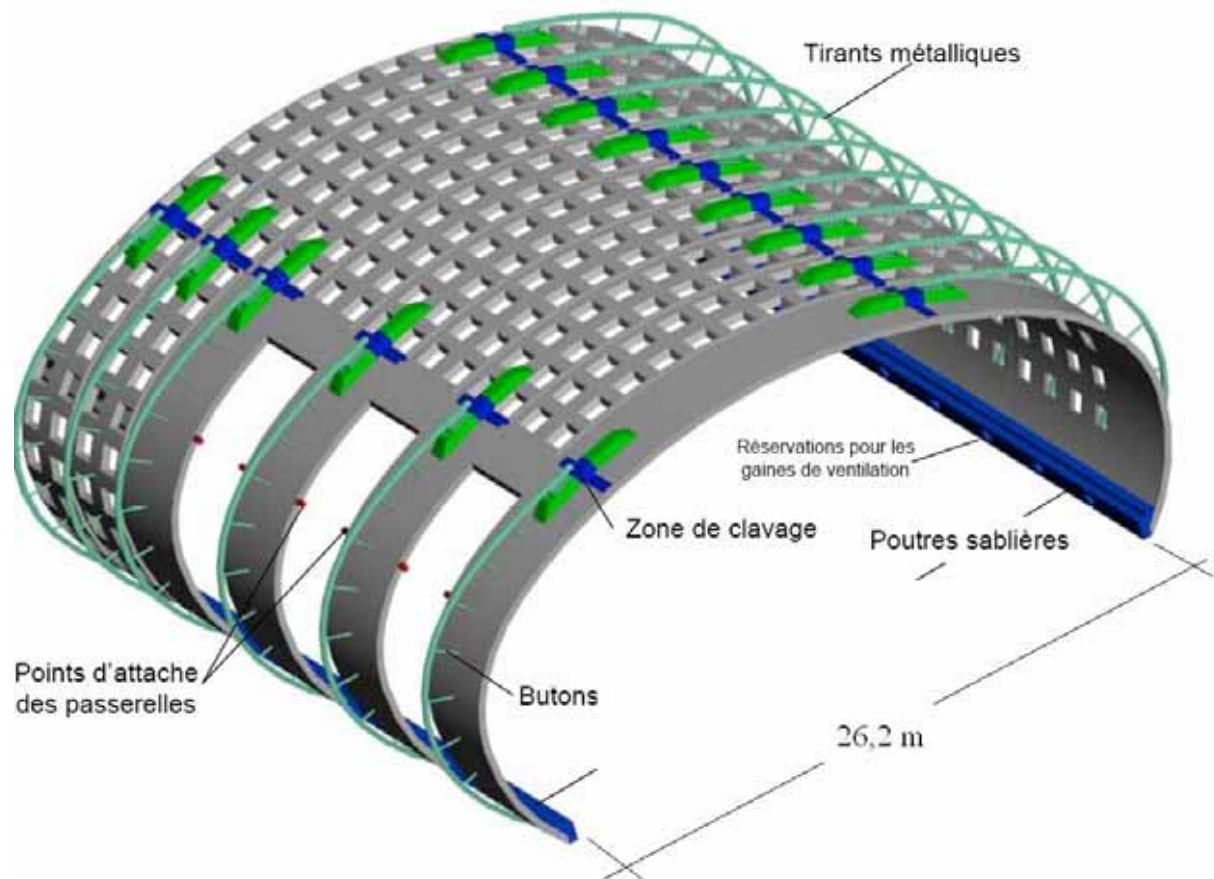


## Internal view





# Structural system



# Failure zone



## Collapsed zone



## Cracks of the outer surface of the shell

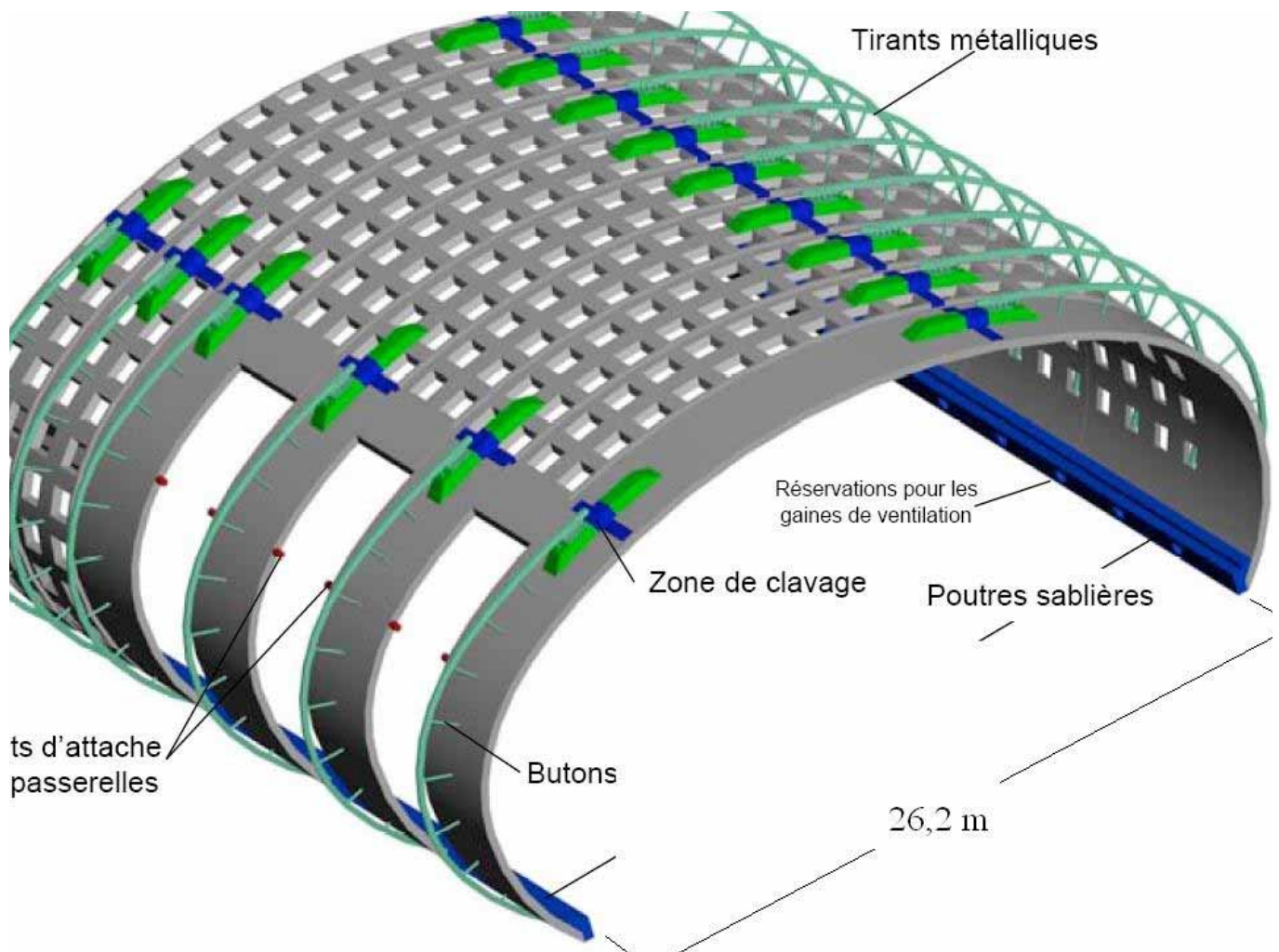


La fissuration est dense et profonde sur cet élément de coque entre les passerelles.



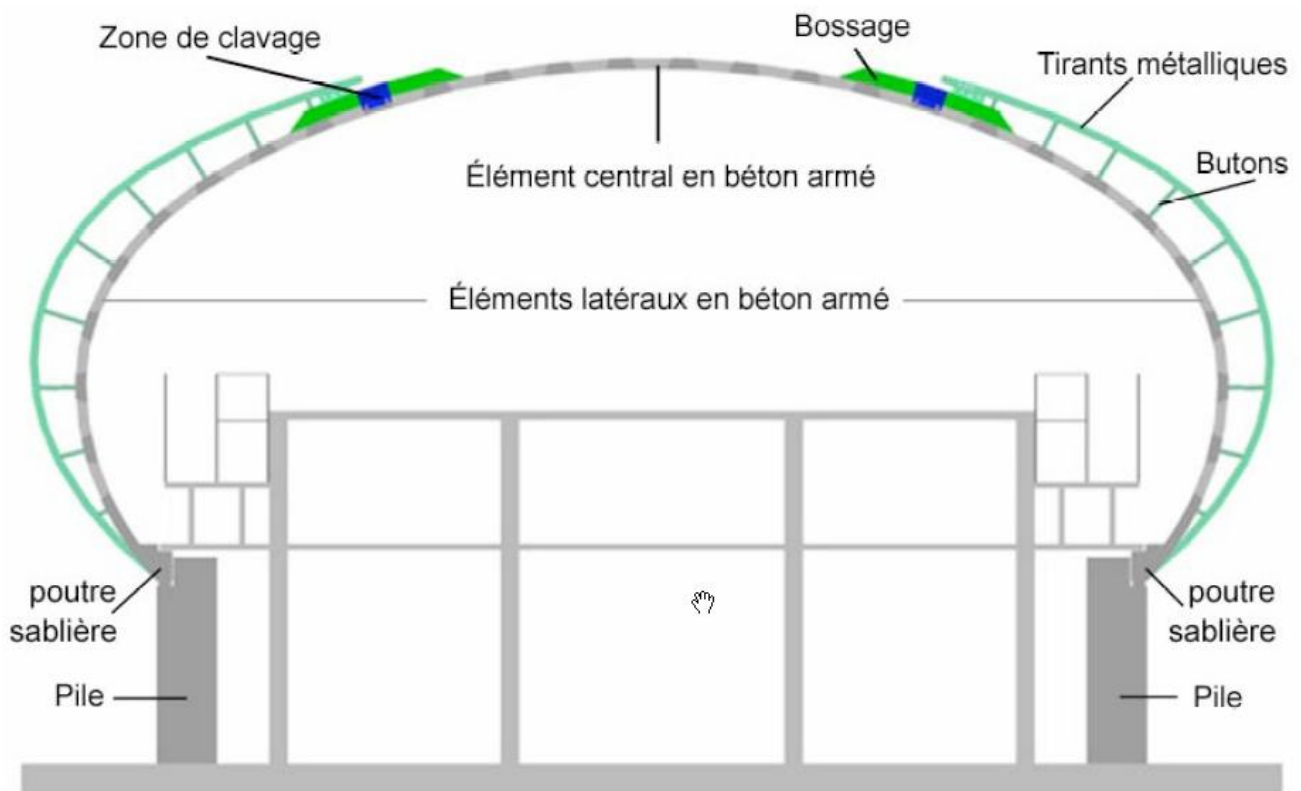
# Rupture of concrete shell

## Détail de la surface de rupture

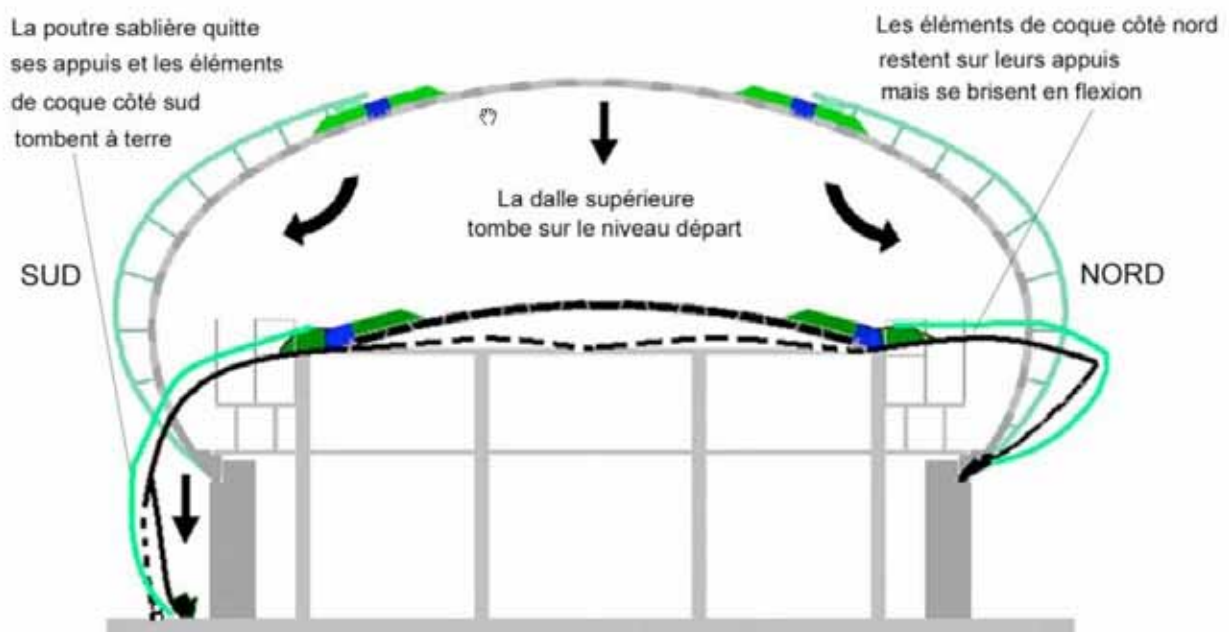




# Transverse section



## High flexibility contributes to a collapse



# Causes of collapse

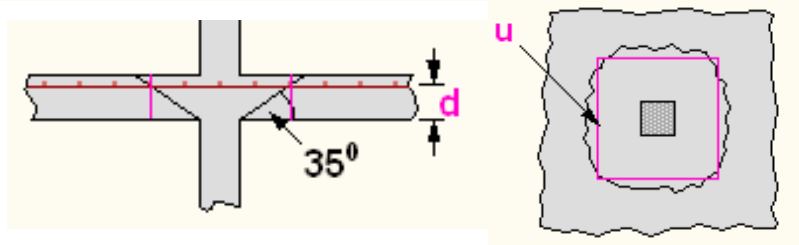
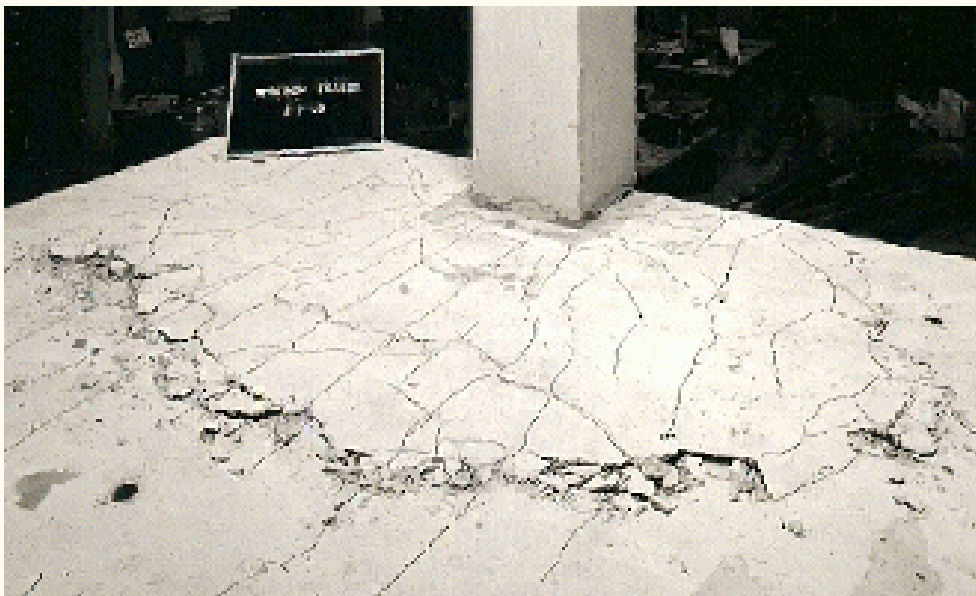
Low initial reserve of strength and progressive weakening due to cracking during construction and cycles of stress from differential thermal and moisture movements between concrete shell and curved steel member and struts

The main factors leading to collapse

- the high flexibility was increased by cracking
- a lack of robustness and redundancy
- the high local punching stresses
- weakness of the longitudinal support beam and its horizontal ties to the columns

The Structural Engineer 5/2005

## Punching shear

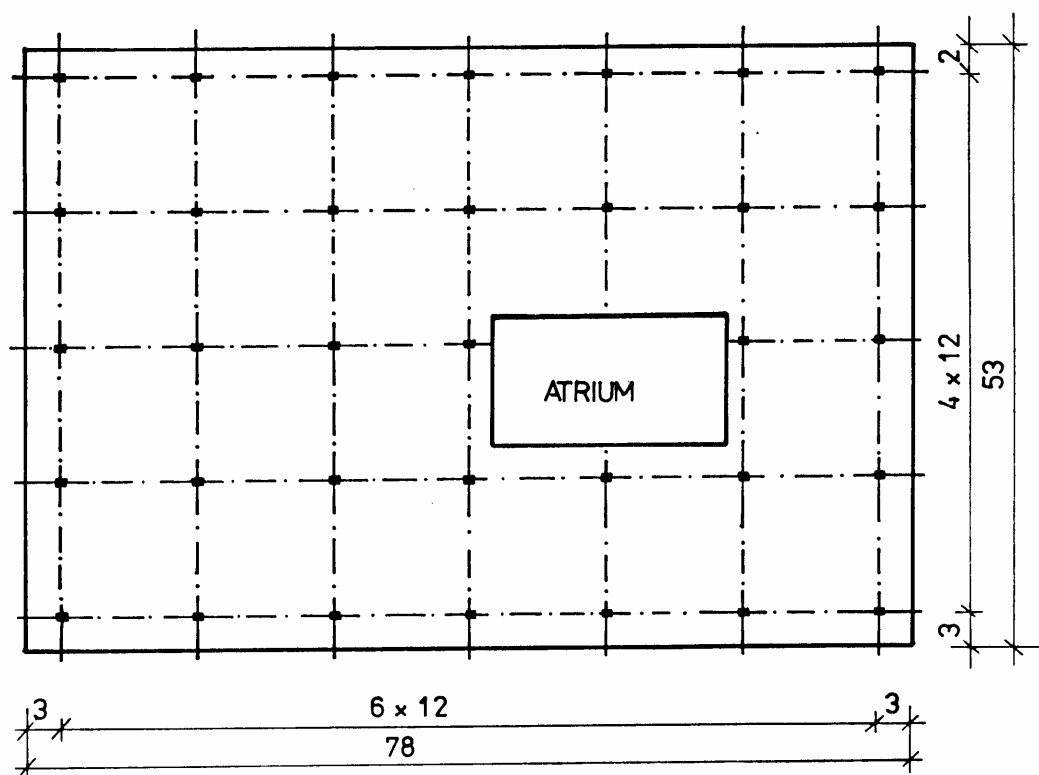




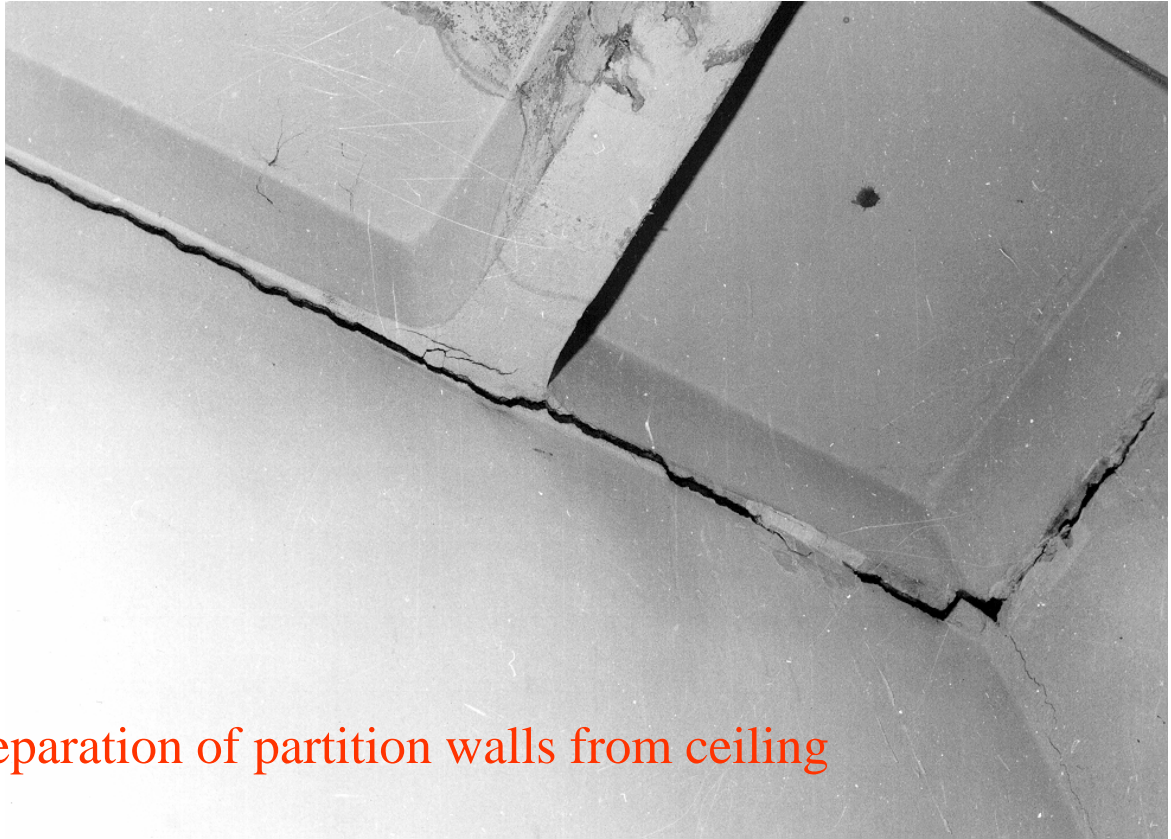
## Pipers Row Car Park, Wolverhampton, 1997



## Serviceability failure of a department store

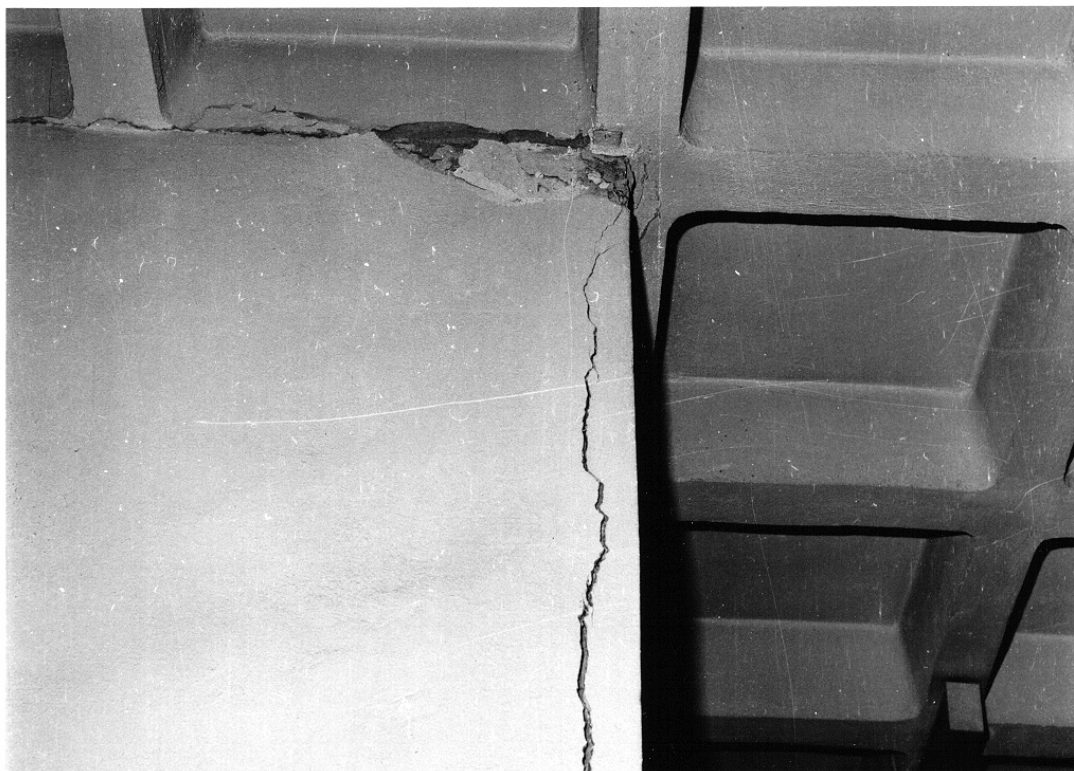


# Differential movements



Separation of partition walls from ceiling

# Cracks in a partition wall





## Environmental influences - cooling towers



## Concrete surface damage



# Maintenance



## Flooding and insufficient robustness





## Failure due to explosion



## Failures due to explosion



# Farmer's story

An example of structural failure due to inappropriate use of a building.

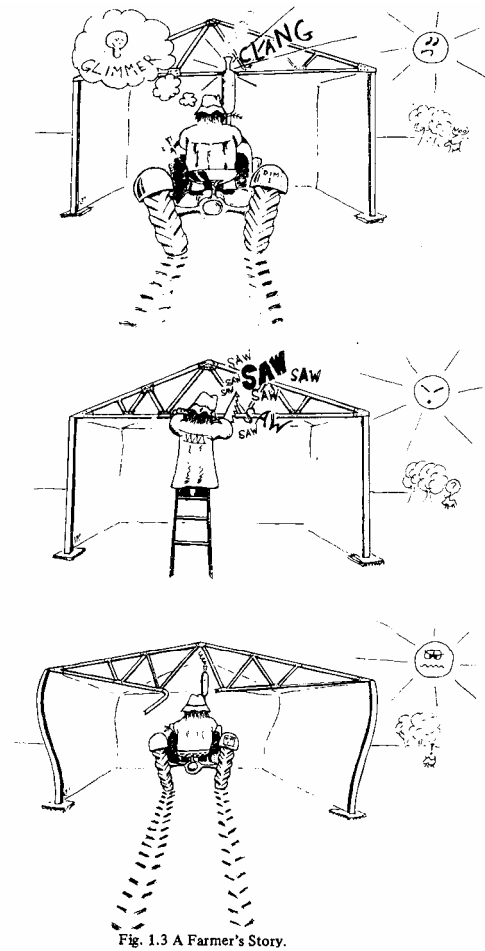
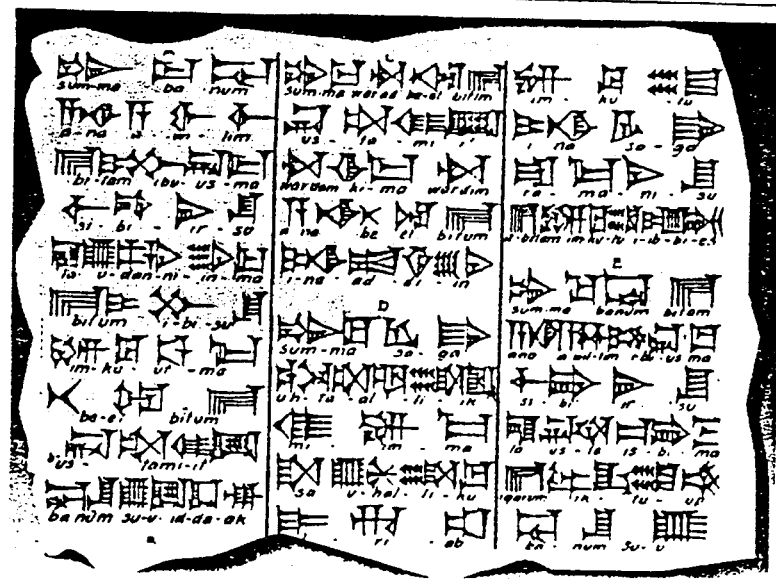


Fig. 1.3 A Farmer's Story.

## The oldest building provision

laws of Hammourabi, Babylon, 2200 BC



If a builder builds a home for a man and does not make its construction firm and the house collapses and causes the death of the owner of the house  
- that builder shall be put to death.